

# EXHIBIT B

Seagate Redacted Version of  
Plaintiffs' Exhibit 25

**From:** Wanda W Pearson <wanda.w.pearson@seagate.com>  
**Subject:** Fwd: Most Reliable HDDs After Analyzing 25,000 Units - Backblaze  
**To:** Sai S Varanasi <sai.s.varanasi@seagate.com>, Ronald E Lane <ronald.e.lane@seagate.com>  
**Cc:** Suzette Simonich <Suzette.L.Simonich@seagate.com>, Joel Hagberg <joel.hagberg@seagate.com>, John D Grieci <john.d.grieci@seagate.com>

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[REDACTED]

## Most Reliable HDDs After Analyzing 25,000 Units – Backblaze

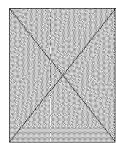
1/ HGST, 2/ WD, 3/ Seagate

This is a Press Release edited by StorageNewsletter.com on 2014.01.31

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This [report](#) has been published on te the blog of Backblaze, author being Brian Beach, principal engineer, [Backblaze, Inc.](#)



### What HDD Should I Buy?


My last two blog posts were about [expected drive lifetimes](#) and [drive reliability](#). These posts were an outgrowth of the careful work that we've done at Backblaze to find the most cost-effective disk drives. Running a truly unlimited online backup service for only \$5 per month means our cloud storage needs to be very efficient and we need to quickly figure out which drives work.

Because Backblaze has a history of openness, many readers expected more details in my previous posts. They asked what drive models work best and which last the longest. Given our experience with over 25,000 drives, they asked which ones are good enough that we would buy them again. In this post, I'll answer those questions.

### Drive Population

At the end of 2013, we had 27,134 consumer-grade drives spinning in [Backblaze Storage Pods](#). The breakdown by brand looks like this:

### HDDs by Manufacturer Used by Backblaze



Seagate	12,765	39,576	1.4
Hitachi	12,956	36,078	2.0
Western Digital	2,838	2,581	2.5
Toshiba	58	174	0.7
Samsung	18	18	3.7

As you can see, they are mostly Seagate and Hitachi drives, with a good number of Western Digital thrown in. We don't have enough Toshiba or Samsung drives for good statistical results.

Why do we have the drives we have? Basically, we buy the least expensive drives that will work. When a new drive comes on the market that looks like it would work, and the price is good, we test a pod full and see how they perform. The new drives go through initial setup tests, a stress test, and then a couple weeks in production. (A couple of weeks is enough to fill the pod with data.) If things still look good, that drive goes on the buy list. When the price is right, we buy it.

We are willing to spend a little bit more on drives that are reliable, because it costs money to replace a drive. We are not willing to spend a lot more, though.

### Excluded Drives

Some drives just don't work in the Backblaze environment. We have not included them in this study. It wouldn't be fair to call a drive 'bad' if it's just not suited for the environment it's put into.

We have some of these drives running in storage pods, but are in the process of replacing them because they aren't reliable enough. When one drive goes bad, it takes a lot of work to get the RAID back on-line if the whole RAID is made up of unreliable drives. It's just not worth the trouble.

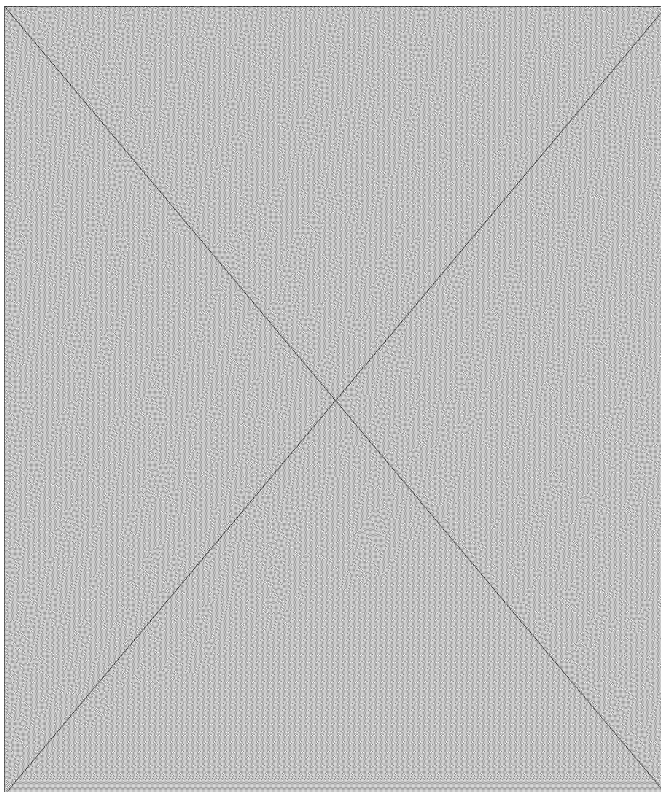
The drives that just don't work in our environment are Western Digital Green 3TB drives and Seagate LP (low power) 2TB drives. Both of these drives start accumulating errors as soon as they are put into production. We think this is related to vibration. The drives do somewhat better in the new low-vibration Backblaze Storage Pod, but still not well enough.

These drives are designed to be energy-efficient, and spin down aggressively when not in use. In the Backblaze environment, they spin down frequently, and then spin right backup. We think that this causes a lot of wear on the drive.

### Failure Rates

We measure drive reliability by looking at the annual failure rate, which is the average number of failures you can expect running one drive for a year. A failure is when we have to replace a drive in a pod.

### Annual Failure Rates



This chart has some more details that don't show up in the pretty chart, including the number of drives of each model that we have, and how old the drives are.

### Number of Hard Drives by Model at Backblaze



Seagate Desktop HDD.15 (ST4000DM000)	4.0TB	5199	0.3	3.8%
Hitachi GST Deskstar 7K2000	2.0TB	4716	2.9	1.1%

(HDS722020ALA330)					
Hitachi GST Deskstar 5K3000 (HDS5C3030ALA630)	3.0TB	4592	1.7	0.9%	
Seagate Barracuda (ST3000DM001)	3.0TB	4252	1.4	9.8%	
Hitachi Deskstar 5K4000 (HDS5C4040ALE630)	4.0TB	2587	0.8	1.5%	
Seagate Barracuda LP (ST31500541AS)	1.5TB	1929	3.8	9.9%	
Hitachi Deskstar 7K3000 (HDS723030ALA640)	3.0TB	1027	2.1	0.9%	
Seagate Barracuda 7200 (ST31500341AS)	1.5TB	539	3.8	25.4%	
Western Digital Green (WD10EADS)	1.0TB	474	4.4	3.6%	
Western Digital Red (WD30EFRX)	3.0TB	346	0.5	3.2%	
Seagate Barracuda XT (ST33000651AS)	3.0TB	293	2.0	7.3%	
Seagate Barracuda LP (ST32000542AS)	2.0TB	288	2.0	7.2%	
Seagate Barracuda XT (ST4000DX000)	4.0TB	179	0.7	n/a	
Western Digital Green (WD10EACS)	1.0TB	84	5.0	n/a	
Seagate Barracuda Green (ST1500DL003)	1.5TB	51	0.8	120.0%	

The following sections focus on different aspects of these results.

### 1.5TB Seagate Drives

The Backblaze team has been happy with Seagate Barracuda LP 1.5TB drives. We've been running them for a long time - their average age is pushing 4 years. Their overall failure rate isn't great, but it's not terrible either.

The non-LP 7200 RPM drives have been consistently unreliable. Their failure rate is high, especially as they're getting older.

### 1.5TB Seagate Drives Used by Backblaze



Seagate Barracuda LP (ST31500541AS)	1.5TB	1929	3.8	9.9%
Seagate Barracuda 7200 (ST31500341AS)	1.5TB	539	3.8	25.4%
Seagate Barracuda Green (ST1500DL003)	1.5TB	51	0.8	120.0%

The Seagate Barracuda Green 1.5TB drive, though, has not been doing well. We got them from Seagate as warranty replacements for the older drives, and these new drives are dropping like flies. Their average age shows 0.8 years, but since these are warranty replacements, we believe that they are refurbished drives that were returned by other customers and erased, so they already had some usage when we got them.

### **Bigger Seagate Drives**

The bigger Seagate drives have continued the tradition of the 1.5Tb drives: they're solid workhorses, but there is a constant attrition as they wear out.

### **2.0 to 4.0 TB Seagate Drives Used by Backblaze**

Seagate Desktop HDD.15 (ST4000DM000)	4.0TB	5199	0.3	3.8%
Seagate Barracuda (ST3000DM001)	3.0TB	4252	1.4	9.8%
Seagate Barracuda XT (ST33000651AS)	3.0TB	293	2.0	7.3%
Seagate Barracuda LP (ST32000542AS)	2.0TB	288	2.0	7.2%
Seagate Barracuda XT (ST4000DX000)	4.0TB	179	0.7	n/a

The good pricing on Seagate drives along with the consistent, but not great, performance is why we have a lot of them.

### **Hitachi Drives**

If the price were right, we would be buying nothing but Hitachi drives. They have been rock solid, and have had a remarkably low failure rate.

### **Hitachi Drives Used by Backblaze**



Hitachi GST Deskstar 7K2000 (HDS722020ALA330)	2.0TB	4716	2.9	1.1%
Hitachi GST Deskstar 5K3000 (HDS5C3030ALA630)	3.0TB	4592	1.7	0.9%
Hitachi Deskstar 5K4000 (HDS5C4040ALE630)	4.0TB	2587	0.8	1.5%
Hitachi Deskstar 7K3000 (HDS723030ALA640)	3.0TB	1027	2.1	0.9%

### Western Digital Drives

Back at the beginning of Backblaze, we bought Western Digital 1TB drives, and that was a really good choice. Even after over 4 years of use, the ones we still have are going strong.

We wish we had more of the Western Digital Red 3TB drives (WD30EFRX). They've also been really good, but they came after we already had a bunch of the Seagate 3TB drives, and when they came out their price was higher.

### Western Digital Drives Used by Backblaze



Western Digital Green (WD10EADS)	1.0TB	474	4.4	3.6%
Western Digital Red (WD30EFRX)	3.0TB	346	0.5	3.2%
Western Digital Green (WD10EACS)	1.0TB	84	5.0	n/a

### What About Drives That Don't Fail Completely?

Another issue when running a big data center is how much personal attention each drive needs. When a drive has a problem, but doesn't fail completely, it still creates work. Sometimes automated recovery can fix this, but sometimes a RAID array needs that personal touch to get it running again.

Each storage pod runs a number of RAID arrays. Each array stores data reliably by spreading data across many drives. If one drive fails, the data can still be obtained from the others. Sometimes, a drive may 'pop out' of a RAID array but still seem good, so after checking that its data is intact and it's working, it gets put back in the RAID to continue operation. Other times a drive may stop responding completely and look like it's gone, but it can be reset and continue running.



Measuring the time spent in a 'trouble' state like this is a measure of how much work a drive creates. Once again, Hitachi wins. Hitachi drives get 'four nines' of untroubled operation time, while the other brands just get 'two nines'.

#### Untroubled Operation of Drives by Manufacturer used at Backblaze

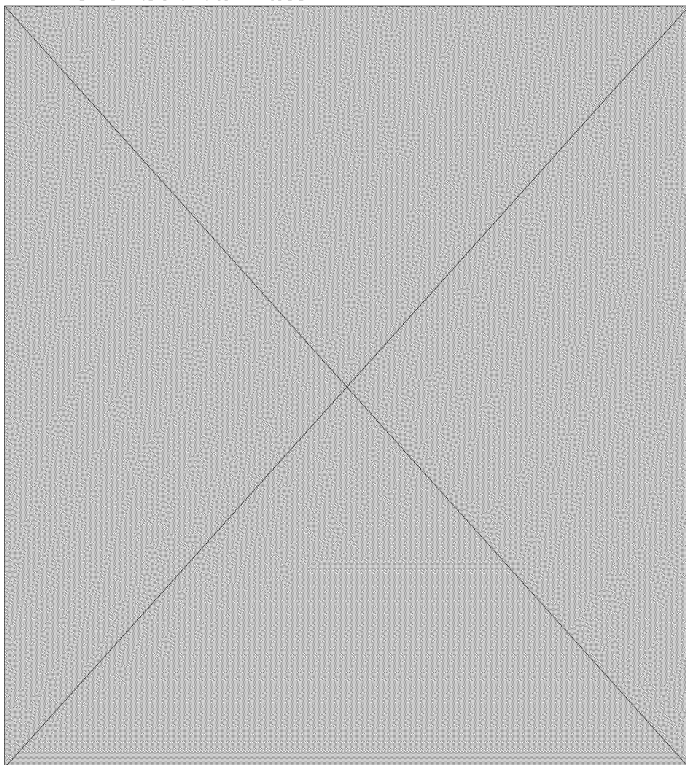


Seagate	99.72	0.28%	12459
Western Digital	99.83	0.17%	933
Hitachi	99.99	0.01%	12956

#### Drive Lifetime by Brand

The chart below shows the cumulative survival rate for each brand. Month by month, how many of the drives are still alive?

#### 36-Month Survival Rate



Hitachi does really well. There is an initial die-off of Western Digital drives, and then they are nice and stable. The Seagate drives start strong, but die off at a consistently higher rate, with a burst of deaths near the 20-month mark.



Having said that, you'll notice that even after 3 years, by far most of the drives are still operating.

### **What Drives Is Backblaze Buying Now?**

We are focusing on 4TB drives for new pods. For these, our current favorite is the Seagate Desktop HDD.15 (ST4000DM000). We'll have to keep an eye on them, though. Historically, Seagate drives have performed well at first, and then had higher failure rates later.

Our other favorite is the Western Digital 3TB Red (WD30EFRX).

We still have to buy smaller drives as replacements for older pods where drives fail. The drives we absolutely won't buy are Western Digital 3TB Green drives and Seagate 2TB LP drives.

A year and a half ago, Western Digital acquired the Hitachi disk drive business. Will Hitachi drives continue their excellent performance? Will Western Digital bring some of the Hitachi reliability into their consumer-grade drives?

At Backblaze, we will continue to monitor and share the performance of a variety of disk drive models. What has your experience been?

## **Our Comments**

We read some negative comments on this report in the US press.

Under the title, *Dispelling Backblaze's HDD Reliability Myth - The Real Story Covered: We chronicle Backblaze's failed attempt to provide credible HDD reliability data. Read on to find out why you should pay no attention at all*

TweakTown wrote:

*"Needless to say, there are holes in the methodology big enough to drive a truck through.*

*"They don't explain the test environment.*

*"The data from Backblaze should not influence a purchasing decision by any consumer, regardless of what type of drive they are purchasing. The innumerable variables, and lack of documentation, ensures the results are unreliable. Even for the winners, the results aren't good; the failure rates are exponentially higher than those observed in the real-world. One should question whether these companies could survive financially with the massive warranty return rates in real-world scenarios."*

Under the title, *Selecting a Disk Drive: How Not to Do Research*  
enterprisestorageforum.com wrote:

*"I wasn't impressed last week when I saw Brian Beach's blog on what disk drive to buy. I wasn't impressed due to the lack of intellectual rigor in the analysis of the data he presented. In my opinion, clearly Beach has something else going on or lacks understanding of how disk drives and the disk drive market work.*

*"There is nothing in the blog about how much data is written to a set of drives that has had failures."*

These comments are not fair.

We congratulate Backblaze for its report as it's the first time to our knowledge that a big user of HDDs published statistics on the reliability of HDDs based on a significant number of devices (25,000) and giving the names of the manufacturers with the precise models. And you cannot suspect Backblaze not to be independent from HDD makers as it runs devices from all of them. If nobody did a research like that, main reason is probably that big users prefer to keep good relationship with their suppliers.

For sure Backblaze published its report to promote its company. But why not?

And at the end, the final ranking in term of reliability (1/ HGST, 2/ WD, 3/ Seagate) is not surprising.

We suggest US commentators to buy 25,000 HDDs, keep them running them for several years and reveal their own results to prove Backblaze is wrong.

We also heard that HDD makers were not happy at all after reading the Backblaze report. For them, we suggest that they reveal their own numbers concerning the hard disk drives they were obliged to replace before the end of the warranty these last years. For sure, they have these statistics. But up to know they never publicly released this information. Do it and once more prove that the Backblaze results are wrong.

----- Forwarded message -----

From: **Robert Volpe** <[robert.volpe@seagate.com](mailto:robert.volpe@seagate.com)>

Date: Fri, Jan 31, 2014 at 2:35 PM

Subject: Most Reliable HDDs After Analyzing 25,000 Units - Backblaze

To: Wanda W Pearson <[wanda.w.pearson@seagate.com](mailto:wanda.w.pearson@seagate.com)>, Noelle Currell <[noelle.currell@seagate.com](mailto:noelle.currell@seagate.com)>

FYI

<http://www.storagenewsletter.com/rubriques/market-reportsresearch/most-reliable-hdds-after-analyzing-25000-units-backblaze/>

**Rob Volpe**

Director, Global Operations Strategy

Seagate Technology

Office Telephone: 720-684-1988

US Cell Phone: 303-351-1110

